600

MODEL 600(A)
GAUSSMETER
Operating and Maintenance Manual

ELECTRONIC DESIGN. • DEVELOPMENT • MANUFACTURING

BELL INC.

6120 Hanging Moss Road
Orlando, Florida 32807
Phone 305/678-6900

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GAUSSMETER

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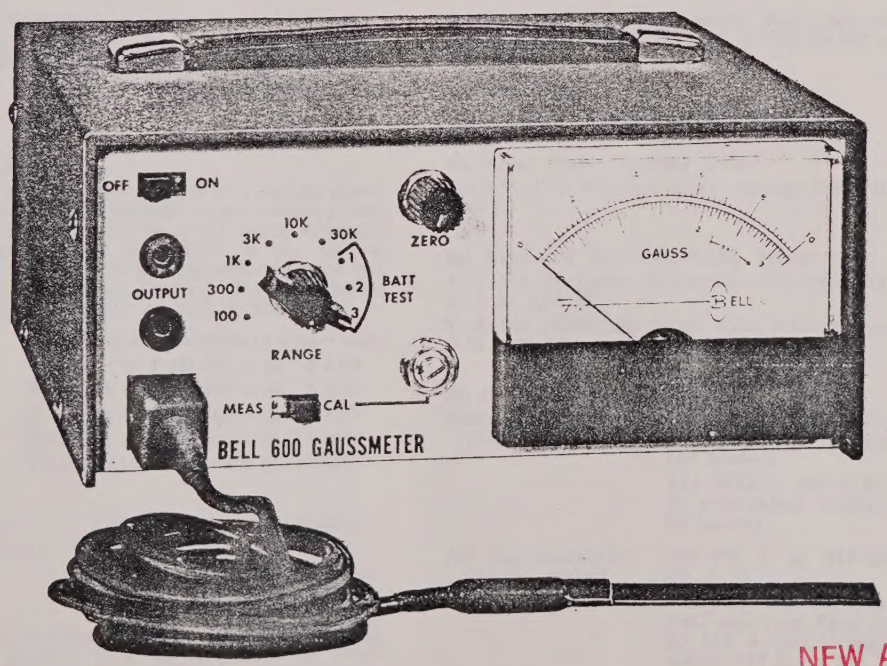

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SECTION I

Specifications

I-1 ELECTRICAL AND PHYSICAL SPECIFICATIONS

(a) Measurement Ranges:
Measurement range extends from 2 G (gauss) per scale division (100 G full scale) to 30 kG full scale. Full scale ranges are in 10 dB steps as follows:

100	1 K	10 K
300	3 K	30 K

(b) Measurement Modes:
Static (dc) fields may be read out directly on the panel meter or monitored as a dc voltage at the output jacks. Varying (ac) fields may be measured using external ac responding instruments connected to the output jacks. Frequency response of the gaussmeter (not including probe effects) is as follows. Probe induced output affects response above approx. 5 kHz.

Full Scale Range	Typical Frequency Response at Output Jacks
100	From dc to 3 dB down @ 1.5 kHz
300	From dc to 3 dB down @ 5 kHz
1 K	From dc to 3 dB down @ 10 kHz
3 K	From dc to 3 dB down @ 15 kHz
10 K, 30 K	From dc to 3 dB down @ 20 kHz

(c) Output Jacks:

1. Output voltage:	1 V full scale uncalibrated
2. Source impedance:	1 kΩ
3. Polarity:	Positive for upscale meter reading; negative for downscale reading

The black jack is common and is grounded to the gaussmeter case. Output jack voltage may be calibrated by using external dc measurement equipment connected to the jacks when performing the calibration procedure. See Section II-3(d).

(d) Calibration:
1. Internal calibrating procedure is referenced to a standard NMR (Nuclear Magnetic Resonance) calibrated magnet traceable to the National Bureau of Standards.

2. Internal calibration error does not exceed ±3% using panel meter for CAL CONSTANT readout.

(e) Accuracy:
±4% F.S. plus calibration accuracy.

(f) Meter Scale Tracking Error:
±1½% F.S. relative to dc voltage linearity at output jacks

(g) Available Standard Probe Types:
1. T-601 miniature transverse with measurement range of 0 to ±30 kG
2. A-601 miniature axial with measurement range of 0 to ±30 kG

(h) Power Requirements:

Battery powered: (Model 600)	(2) NEDA 1810 — Eveready 226 or equivalent (approximate life 160 hours) (1) NEDA 926 — Eveready 732 or equivalent (approximate life 40 hours)
AC line powered: (Model 600A)	105-125 V or 210-250 V, 50-60 Hz, 5 W The fuse clip accepts a standard 3AG size fuse. Fuse rating should be 1/8 A 250 V Slow Blow for either 117 V or 234 V operation.

(i) Overall Dimensions:
4¼" high 8¼" wide 8¼" deep

(j) Weight:
With batteries installed: 7½ lbs. net
With ac power supply installed: 6 lbs. net

SECTION II

Installation and Pre-Operation Adjustments

II-1 POWER

(a) Battery Installation:

To install batteries in the Model 600, remove the four screws on each side of the unit, then lift off cover. Remove the large battery retaining strap and set battery into position. Connect wires to battery with the red lead connecting to the positive (+) battery terminal. The two small batteries are snapped to the wire terminals, then secured in their retaining clips. When replacing cover, use care not to over-tighten screws. Batteries required are (2) Eveready 228 or equivalent (NEDA 1810) and (1) Eveready 732 or equivalent (NEDA 926). Remove batteries promptly when exhausted and before storing the unit for an extended period to prevent corrosion damage.

(b) AC Operation:

The Model 600A is equipped with a self-contained ac power supply. Make certain the power to be used matches the voltage and frequency ratings of the gaussmeter. The unit is normally wired for 117 V operation; for 234V it is necessary to series connect the power transformer primaries. See the schematic diagram (Figure IV-2) for required jumper connections. The power cord is equipped with three conductors and is terminated in a three-prong plug. The round pin is connected to the case and grounds the instrument case and output terminals when used with the appropriate receptacle. This ground is for the protection of operating personnel. Only when a ground is supplied by associated equipment should this ground be unused to prevent common ground currents.

(c) Preliminary Operation:

Connect a probe to the input socket. With power off, tap meter face lightly and check for accurate zero adjustment. If necessary, adjust the screw on the meter face to bring the pointer to exactly zero reading. Set the panel controls as follows:

RANGE switch to 30 K
FUNCTION switch to MEAS
ZERO control to mid-position

Turn the power switch on and allow a few minutes warm-up before calibrating or making any measurements. If the gaussmeter is battery powered, the battery condition may be checked by momentarily turning the RANGE switch through the battery test positions and checking that meter reads in the indicated battery range. Test positions 1 and 2 monitor the two small (NEDA 1810) batteries; position 3 tests the large rectangular (NEDA 926) battery. The two small batteries should be replaced as a pair, however their service life will be considerably longer than that of the large screw-terminal battery.

II-2 PROBE ZEROING ADJUSTMENT

To reduce the residual probe output to zero, the ZERO control is used. Rotate the RANGE switch counterclockwise from the 30 K range until a reading is obtained on the meter. Adjust the ZERO control while reducing the range setting until a zero is obtained on the 100 G range. The earth's magnetic field will normally have only a silght effect and can be disregarded in most measurements. If the residual field is unusually high, it may be necessary to place the probe in a magnetic shield, such as the accessory zero gauss chamber, to obtain a true zero.

II-3 CALIBRATION PROCEDURE

(a) General:

The calibration procedure should be carried out before using the instrument for magnetic field measurements. It must also be made whenever probes are changed. Allow sufficient time for warm-up stability before calibrating. Calibration consists of adjusting the gaussmeter to compensate for the sensitivity of the particular probe to be used and may be done by using one of the following two methods:

(b) Calibration Against Internal CAL Signal:

Calibration against the internal CAL signal is a simple, easy-to-apply technique which will, in most cases, produce the best possible accuracy. Each probe is assigned a CAL CONSTANT. This is a three-digit number representing the sensitivity of that particular probe. To set this information into the gaussmeter, first move the function switch to the CAL position. The screwdriver-slotted CAL control is then adjusted to obtain a meter reading on the upper meter scale corresponding to the CAL CONSTANT. For example, a CAL CONSTANT of .795 would be adjusted for a meter reading of 0.795. The RANGE switch may be set to any one of the measurement ranges, however, calibration cannot be done in the BATT TEST positions. The slide switch is then returned to the MEAS position. Measurements may now be made to the accuracy shown in the specifications under Section I-1.

(c) Calibration Against a Reference Magnet:

If a high accuracy calibration magnet is available, it may be possible to obtain somewhat more accurate calibration for values of flux mesurement near the value of the calibration magnet. The Hall probe must be carefully positioned in the reference field to the correct location and orientation to respond to the correct field magnitude (maximum reading) without alignment errors. Set the RANGE switch to the proper range giving the maximum on-scale meter reading. Adjust the CAL control to obtain the correct flux reading on the meter. The function switch remains in the MEAS position.

(d) Calibration for External Readout Instruments:

An external readout instrument such as a digital voltmeter may be used for higher resolution if the output jack voltage has been first calibrated. This may be done by using either of the previously described calibration techniques except that the CAL control is adjusted for the correct reading on the external readout rather than on the panel meter. In the CAL position of the function switch, the probe CAL CONSTANT is read out in volts. If a reference magnet is used, calibration should be done on a decade (100 G, 1 K, 10 K) range. Measurements made with external readout are most conveniently made on the decade ranges where direct readout may be made with 1 V corresponding to full scale. The 300 G, 3 K, and 30 K ranges will produce 1 V output for flux levels of $100\sqrt{}10$, $1000\sqrt{}10$, and $10{,}000\sqrt{}10$ gauss respectively. If ac flux measurements are to be made, ac readout instrumentation may also be connected to the output jacks. The magnitude of ac voltage appearing at the jacks has the same relationship to ac flux level as dc voltage has to dc flux measurements. See Section I-1(b) for frequency limitations.

SECTION III

Operating Instructions

III-1 THE PROBE

(a) Probe Types:

A transverse probe, as its name implies, has its flux response direction transverse to the probe handle axis. The element is encapsulated in the end of a flexible strip to reduce the possibility of breakage due to stressing by the handle. The probe strip has nominal dimensions of 1/16 inch thick by 9/32 inch wide. Maximum Hall output is produced when the flux vector enters the probe at right angles (90°) to the plane of the element surface. Magnetic fields entering the element at some other angle to the surface cause an output proportional to the 90° component. That is, the response will be B cos θ where B is the field magnitude and θ is the angle of the field to the perpendicular. See Figure III-1.

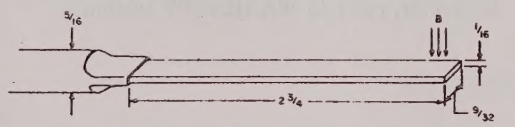


FIGURE III-1 — TRANSVERSE PROBE STG3-0404

The axial probe has its flux response direction along the axis of the probe handle. The element is encapsulated on the end of the probe extension tube. The tube has a nominal diameter of ¼ inch. If the field is directed at some angle with respect to the probe axis, only the axial component will produce an output, just as only the transverse component will produce output for transverse probes. See Figure III-2.

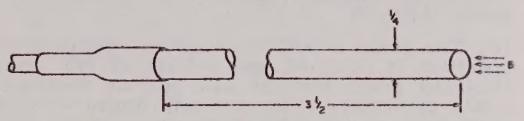


FIGURE III-2 — AXIAL PROBE PAG3-2504

(b) Probe Handling Precautions:

Although the probe is quite rugged, reasonable care should be exercised in handling. Avoid excessive shock, pressure, bending or otherwise straining the element mount. The element can be fractured if the mounting is over-stressed since it is brittle as well as rigid. Particular care should be taken not to flex or strain the area within ½ inch of the transverse probe tip since the Hall generator is contained in this area. The probes should also be protected from touching very hot or cold objects or exposure to temperatures in excess of the —20° C to +60° C range.

III-2 MEASUREMENT PROCEDURE

(a) General:

After completing the preoperational adjustments described in Section II, the unit is ready for operation. It is advisable to position the probe in the measurement position using a clamp or probe holding fixture. Excessive clamping pressure must be avoided to prevent permanent probe damage. The CAL and ZERO adjustments should be checked periodically and readjusted if necessary. It is not necessary to remove the probe from the test position when checking calibration using the CAL CONSTANT technique.

(b) Operation:

For measuring dc fields, set the function switch to MEAS and the RANGE switch to a range higher than the expected field. If a downscale meter reading is obtained, it will be necessary to physically reverse the probe. If this cannot be done, it will necessary to use an external readout instrument capable of reading the negative voltage from the output jacks. See Section II-3(d) for calibration procedure with external instrumentation. To read the magnitude of the field, adjust the probe for maximum reading. If a desired direction component of a field is to be measured, set the probe so that the sensitive direction aligns with the desired component. The meter will then read the component.

The measured value is determined from the meter reading and RANGE switch setting. The RANGE switch indicates the full scale value in gauss of the meter reading. For example, if the RANGE switch is set on 10 kG and the meter reads 1.0 on the 0 to 1 scale, then the field is 10 kG. If the meter reading were 0.5, then the field would be 5,000 gauss. When the RANGE switch is on the 300, 3 K, or 30 K range, the meter reading is taken from the lower scale. A RANGE switch setting of 300 G and a reading of 2 on the lower scale would indicate 200 gauss.

For measuring ac fields, the probe orientation procedure is the same as for dc fields. It is necessary to use external ac responding instrumentation for readout. See Section II-3(d).

Do not attempt to measure a small dc field in the presence of a larger ac field or a small ac field in the presence of a larger dc field due to the possibility of amplifier overload and erroneous readings.

SECTION IV

Maintenance

IV-1 TROUBLE SHOOTING

The following suggestions and procedures are recommended when difficulty is encountered in operating the instrument:

(a) If unit is battery powered, check for weak or exhausted batteries. Gaussmeter may not function properly if the voltage of any of the three batteries falls below 8½ volts.

(b) The probe should be checked whenever erratic operation is obtained, particularly at low levels. A fractured probe element will produce unstable and erratic operation and the zero adjustment will become particularly unstable. Check the cable also for damaged insulation or wire breakage.

(c) The only internal adjustment contained in the gaussmeter is the offset null adjustment R108. This compensates for the inherent offset voltage of the integrated amplifier. It is factory adjusted to permit the front panel zero control to have equal plus and minus range. It should require readjustment only if IC 101 is replaced.

(d) Refer to the circuit diagrams and to the parts lists, by using schematic reference symbols, to obtain detailed information on parts used.

(e) It is important to replace parts with the same type and electrical value as originally used. Parts having F. W. Bell, Inc. part numbers are parts designed especially for the Model 600 and should be obtained directly from the factory.

(f) If necessary to return this instrument to the factory for repair, refer to WARRANTY section.

ABBREVIATIONS

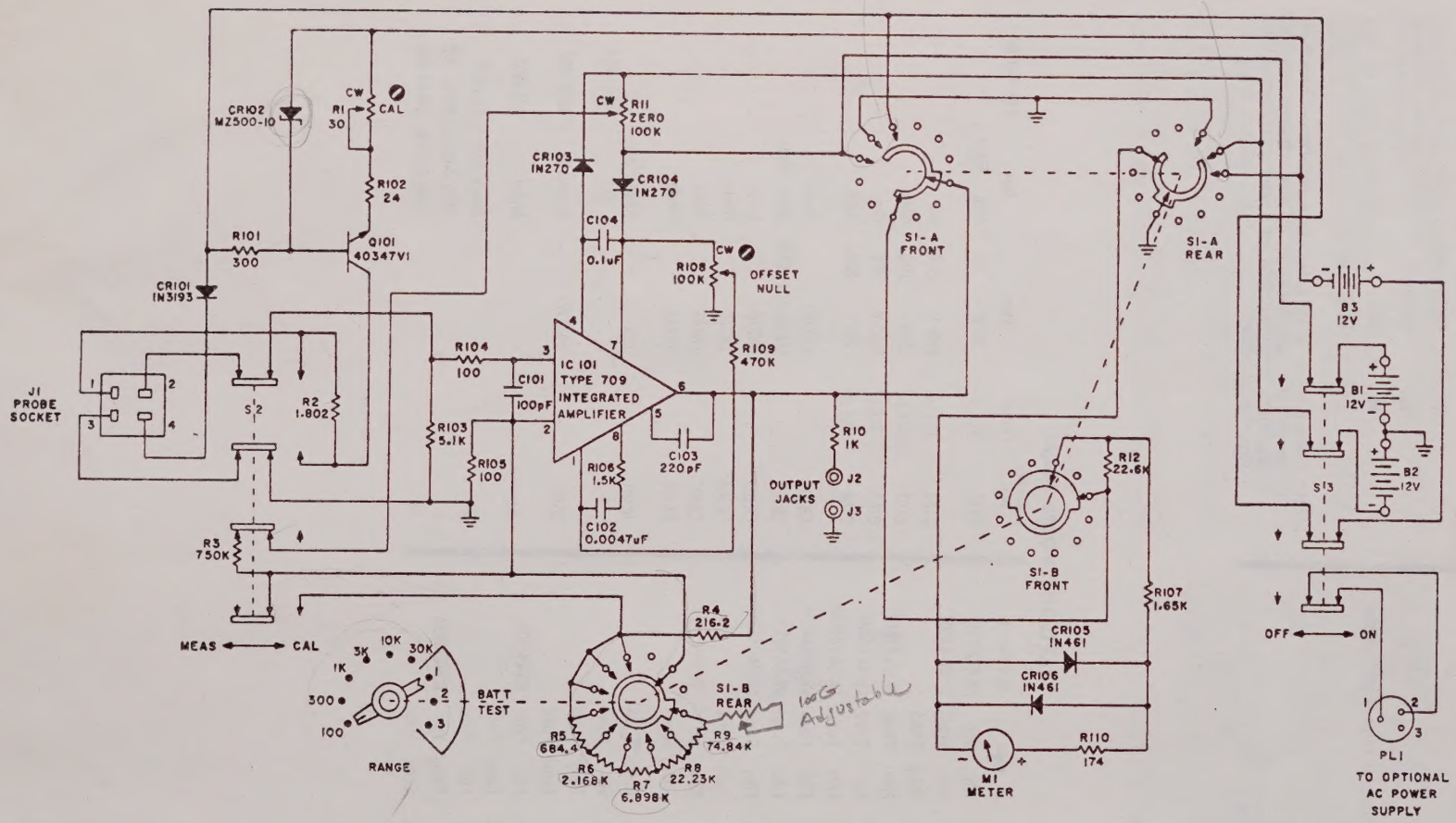
Cer	Ceramic
Comp	Composition
EM	Electrolytic miniature type
F	Farad
Film	Metal Film
FOP	Factory adjusted for optimum performance
HM	Hot molded
K	Kilo or 10^3
M	Meg or 10^6
μ	Micro or 10^{-6}
MME	Molded miniature epoxy
Ω	ohm
P	Pico or 10^{-12}
V	Working volts
Var	Variable
W	Watt
WW	Wire wound

Note: Components with schematic reference numbers below 100 are located in the chassis wiring; numbers between 100 and 200 are located on the circuit board.

PARTS LIST MODEL 600(A)

Schematic Ref.	Value	Spec.		Type		Bell Part No.
R1	30 Ω			WW	Var	RB-477-015
R2	1.802 Ω	1/10 W	1/10%	WW	Fixed	RL-18-1X802
R3	750 kΩ	½ W	5%	Comp	Fixed	
R4	216.2 Ω	⅛ W	¼%	Film	Fixed	RK-35-216X2
R5	684.4 Ω	⅛ W	½%	Film	Fixed	RK-34-684X4
R6	2.168 kΩ	⅛ W	½%	Film	Fixed	RK-34-2X168K
R7	6.898 kΩ	⅛ W	½%	Film	Fixed	RK-34-6X898K
R8	22.23 kΩ	⅛ W	½%	Film	Fixed	RK-34-22X23K
R9	74.84 kΩ	⅛ W	½%	Film	Fixed	RK-34-74X84K
R10	1 kΩ	½ W	5%	Comp	Fixed	
R11	100 kΩ			Comp	Var	RA-1812
R12	22.6 kΩ	¼ W	1%	Film	Fixed	
R101	300 Ω	½ W	5%	Comp	Fixed	
R102	24 Ω	2 W	5%	WW	Fixed	
R103	5.1 kΩ	½ W	5%	Comp	Fixed	
R104	100 Ω	½ W	5%	Comp	Fixed	
R105	100Ω	¼ W	½%	Film	Fixed	RK-24-100
R106	1.5 kΩ	½ W	5%	Comp	Fixed	
R107	1.65 kΩ	¼ W	1%	Film	Fixed	
R108	100 kΩ			Comp	Var	RS-02-100K
R109	470 kΩ	½ W	5%	Comp	Fixed	

Schematic Ref.	Value	Spec.		Type	Bell Part No.
R110	174 Ω	¼ W	1%	Film Fixed	
C101	100 pF	1000 V	20%	Cer	
C102	0.0047 μF	200 V	10%	MME	
C103	220 pF	1000 V	20%	Cer	
C104	0.1 μF	200 V	10%	MME	
CR101		1N3193		Diode	
CR102		MZ500-10/1N708		Zener Diode	
CR103		1N270		Diode	
CR104		1N270		Diode	
CR105		1N461		Diode	
CR106		1N461		Diode	
IC101		709		Integrated Ckt.	JM-01-001
Q101		40347V1		Transistor	JK-01-002
M1				Meter	MB-1902
S1				Range Switch	SA-1858
S2				Slide Switch	SW-01-003
S3				Slide Switch	SW-01-003

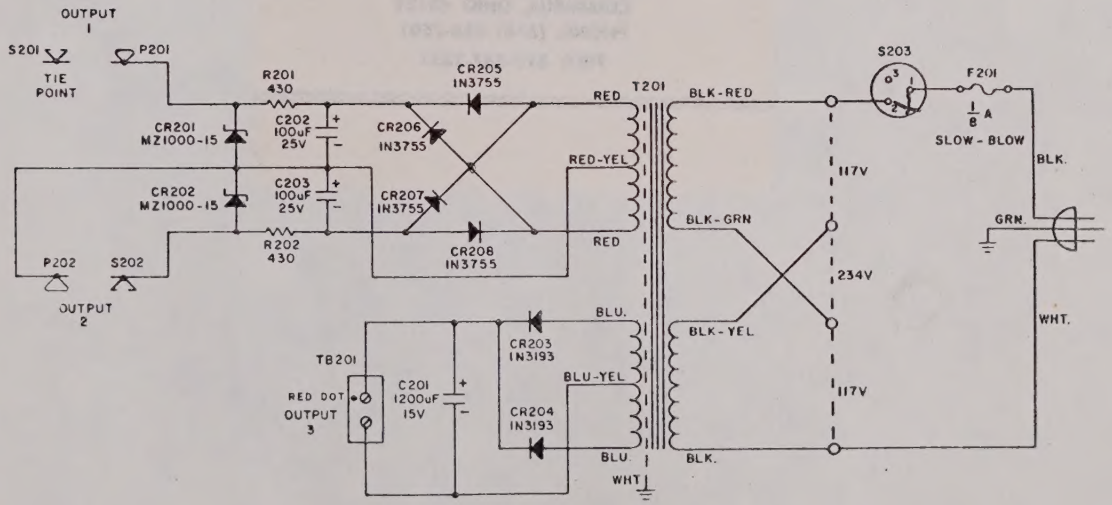


SCHEMATIC CIRCUIT DIAGRAM
MODEL 600

FIGURE IV-1

Additional Parts for Optional AC Power Supply

Schematic Ref.	Value	Spec.	Type	Bell Part No.
R201	430Ω	2 W 5%	WW Fixed	
R202	430Ω	2 W 5%	WW Fixed	
F201	⅛ A 250 V Slow Blow Fuse			
C201	1200μF	15 V	EM	
C202	100μF	25 V	EM	
C203	100μF	25 V	EM	
T201	Power Transformer			LB-1938
CR201	MZ1000-15		Zener Diode	JF-05-12
CR202	MZ1000-15		Zener Diode	JF-05-12
CR203	1N3193		Diode	
CR204	1N3193		Diode	
CR205	1N3755		Diode	
CR206	1N3755		Diode	
CR207	1N3755		Diode	
CR208	1N3755		Diode	



SCHEMATIC CIRCUIT DIAGRAM
POWER SUPPLY YB-2062

FIGURE IV-2

SECTION V

Warranty

F. W. BELL, INC. warrants each instrument of its manufacture to be free from defects in material and workmanship. Our obligation under this warranty is limited to servicing or adjusting any instrument returned to our factory for that purpose, and to replacing any defective parts thereof (excluding electron tubes, batteries, transistors and probe sensing elements, which parts are covered by a standard EIA 90-day warranty). This warranty covers instruments which, within one year after delivery to the original purchaser, shall be returned with transportation charges prepaid by the original purchaser, and which upon examination shall disclose to our satisfaction to be defective. If it is determined that the defect has been caused by misuse or abnormal conditions of operation, repairs will be billed at cost after submitting an estimate to the purchaser.

F. W. BELL, INC. reserves the right to make changes in design at any time without incurring any obligation to install same on units previously purchased.

This warranty is expressly in lieu of all other obligations or liabilities on the part of F. W. BELL, INC., and F. W. BELL, INC. neither assumes nor authorizes any other person to assume for them any other liability in connection with the sales of F. W. BELL, INC. instruments.

DAMAGE IN SHIPMENT

The instrument should be examined and tested as soon as it is received. If it does not operate properly or is damaged in any way, immediately file a claim with the carrier. The claim agent will provide report forms. A copy of the completed form should be forwarded to us. We will then make the necessary arrangements for repair or replacement. All correspondence concerning this instrument should include model and serial numbers.

SHIPPING INSTRUCTIONS

All shipments of F. W. BELL, INC. instruments should be made via Railway Express or Motor Freight. Always use the original shipping carton and inserts, if possible, or pack the instrument in a sturdy container and surround the entire instrument with two or three inches of excelsior or similar shock-absorbing material.

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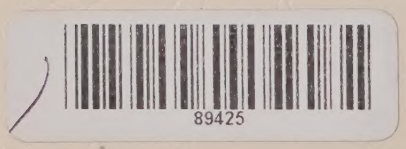
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